Pseudo-spin of time-like lepton and the solar neutrino problem

Vo Van Thuan
Institute for Nuclear Science and Technique
Hoang Quoc Viet Street, Nghia Do, Hanoi, Vietnam
E-mail: vkhkthn@netnam.org.vn

Abstract

Based on the dual principle in super-luminous Lorentz transformation this work shows that pseudo-spin of a time-like bradyon appears to space-like observers as iso-spin of a corresponding tachyon. Due to the weak interaction, lepton-tachyon appears as neutrino with hidden imaginary transcendent mass, suppressed by a factor of $\rho \sim G_F m_0^2$ compared to the rest mass m_0 of a corresponding space-like lepton. Assuming a coexistence of tachyon dark matter in the solar system, we show that the solar neutrino deficit might be explained by depolarisation of time-like electrons due to elastic scattering in time-like plasma and the maximal deficit would reach 0.5. Neither day-night nor seasonal effects are expected due to dynamic balance of fluxes with opposite pseudo-spin polarisation.

I. INTRODUCTION

E. Recami et al. [1] suggested that space-like tachyon is , in fact, time-like bradyon, travelling in three-dimension time and one-dimension space. Space-like and time-like bradyons behave in their own "spaces", in complete symmetry. However, space-like tachyon has never been observed in practice. We have suggested in Refs. [2,3] that tachyon transcendent mass is complex, which would be observed by means of the weak interaction. Consequently, both minus square mass and real part of transcendent mass as dynamic parameters should be suppressed by a factor of $\rho^2 \sim G_F^2 m_0^4$ compared to the rest mass m_0 (G_F is Fermi coupling constant). In case of lepton, the factor ρ is negligible small and lepton-tachyons are always identified as luxons, i.e. luminous particles moving with speed of light, such as neutrinos. Based on this assumption we have given a qualitative interpretation of the results of the oscillation experiments at accelerators (including LSND, CARMEN and NOMAD) and nuclear reactors [3]. As a further development, the present paper introduces an alternative approach to solve the solar neutrino problem discovered 31 years ago by R. Davis et al. [4] and reconfirmed in later experiments [5,6,7,8]. Within this approach one is able also to give a qualitative explanation to the negative result of recent Super-Kamiokande experiments which have not seen the day-night effect [9].

II. TRANSCENDENT MASS OF NEUTRINOS AS REALISTIC TACHYONS

As suggested in Refs. [2,3] the complex transcendent mass m^∞ of tachyon has a dominant imaginary part Im (m^∞) and a minor real part Re (m^∞). For lepton-tachyons, we assume that the imaginary part may show up only in an interference between the weak interaction and the electro-magnetic or strong interaction, i.e. Im (m^∞) = $\alpha_i \rho m_0$, where α_i is the coupling constant of i-type interfering interaction. Absolute value of the minus square mass and the real part are to be observed in full weak interaction and should be of the second order of the Fermi constant as $|\mathrm{Im}\ (m^\infty)|^2 = {\alpha_i}^2 \rho^2 m_0^2 = {\alpha_i}^2 m_0 \mathit{\Gamma}/2$ and $\mathrm{Re}\ (m^\infty) = \rho^2 m_0 = \mathit{\Gamma}/2$, where m_0 is the rest mass and $\mathit{\Gamma} = 192^{-1}\pi^{-3}\mathrm{G}_F^2 m_0^5$, the decay width of a corresponding lepton-bradyon. Observable transcendent masses of lepton-tachyons are given in Table 1.

Table 1. Estimated observable transcendent mass of lepton-tachyons

lepton-bradyon	electron	μ-meson	τ-lepton
m_0, MeV	0.51	105.6	1780
$\mathit{\Gamma}$, eV	$< 5.10^{-22}$ (*)	2.5 10^{-10}	˜10^{-3}
ρ^2	5.10^{-28}	1.2 10^{-18}	3. 10^{-13}
$\mathrm{Im}(\mathrm{m}^\propto)\alpha_i^{-1}$, eV	1.1 10^{-8}	0.116	979
$|\mathrm{Im}(\mathrm{m}^\propto)|^2\alpha_i^{-2}$, eV^2	1.2 10^{-16}	1.34 10^{-2}	9.5 10^5
$\mathrm{Re}(\mathrm{m}^\propto)$,eV	$\leq$2.5 10^{-22}	1.25 10^{-10}	5. 10^{-4}

(*) *A similar formula for $\mathit{\Gamma}$ of unstable leptons was extended to electron*

These lepton-tachyons are supposed to exist as neutrinos. As a result, neutrinos should behave in their own super-luminous reference frame as time-like bradyons, which, according to the dual principle, should have similar properties as space-like bradyons in sub-luminous reference frame. Particularly, they have "spin", which, in difference from the space-like leptons, is a dipole moment in three-dimension time. To a space-like observer, this pseudo-spin looks like an iso-spin.

III. AN ALTERNATIVE SOLUTION TO THE SOLAR NEUTRINO PROBLEM

The solar neutrino fluxes measured in different experiments are reviewed in Table 2.

Table 2. Solar neutrino flux (SNU): measurements and theory

Exp. & Method	Theor. calculation	Exp.	Exp./Theor.
Homestake:			
Chlorine;total[5]	$9.3{+}1.2-1.4$	$2.55{\pm}0.14 \pm 0.14$	0.27
Kamiokande:			
water;B^8[6]	6.6±0.9	$2.805{\pm}0.19 \pm 0.33$	0.42
Sage:			
Gallium;total[7]	137+8-7	$74{\pm}12 + 8 - 7$	0.54
Gallex:			
Gallium;total[8]	137+8-7	$77{\pm}9 + 4 - 5$	0.55

In Table 2 the measured neutrino flux is significantly smaller compared to the calculation from the standard solar model (SSM) [10]. The data of Ref. [5] is by a factor of 3 below prediction, while other data are more or less equal half of prediction [6,7,8]. The average ratio of total neutrino spectrum measurements in Refs. [5,7,8] is 0.46 $\pm$0.06. All efforts to improve the theoretical SSM have not succeeded to explain the experiments. A natural way was to assume that probably there is oscillation of solar neutrinos, which might be enhanced by MSW resonance mechanism in matter [11] or in vacuum [12]. However, Super-Kamiokande collaboration showed that there is no day-night effect which would happen if the resonance enhancement took place in the Earth matter [9]. The seasonal variation, if exists, would be less than 5% of the solar neutrino flux observed by Super-Kamiokande [13]. For solar neutrino the oscillation parameter $\Delta m^2 \sim 10^{-5}$-10^{-6} eV^2 is too small to agree with oscillation from atmospheric or accelerator data.

This situation stimulated us to look for a new alternative solution of the problem, considering neutrino as tachyon in our sub-luminous reference frame, or as time-like bradyon in super-luminous frame.

V. De Sabbata et al. [14] proposed that a black-hole may be a trap for tachyons, in which, i.e., inside the horizon they behave them-selves as time-like bradyons. As a black hole is involved in gravitation, its radius R calculated by Schwarzshild model has a linear dependence on mass: R (km)$\approx$GM_b /c^2 (G is the gravitation constant). For example, a black hole of the same radius as of the Sun should have mass M_b = 3.10^5 M_s (where M_s is solar mass). Those black holes could not exist inside the Sun, because of huge gravitational collapse they might cause to the Sun as a middle-size star. The picture will change, as according to our hypothesis, the black holes contain tachyon matter, which hardly interacts with space-like one. The real part of tachyon mass Re(m*)* involved into gravitation is suppressed by a weak interaction factor of ρ^2=$192^{-1}\pi^{-3}G_F^2 m^4$. For the black hole containing time-like mass with an abundance as in the Sun, we may put m $\approx$1.2 m_p (where m_p is proton mass), which leads to the observable mass of the black hole $M_b^* \approx 10^{-8} M_s$. This means that the tachyon black hole of extremely huge transcendent mass is able to exist inside the Sun without collapse!

Consequently, we assume, that there can be in the solar center a concentration of tachyon dark matter of time-like plasma, containing time-like electrons and lightest time-like nuclei, i.e. proton and helium. As a result, solar neutrinos have to pass through this area, scattering in a similar way as space-like electrons interact with plasma. In according to Ref. [15] we considered a 100% initially polarised electron flux and calculated its depolarisation, which depends on the thickness of scattering plasma medium as shown in Fig.1.

In the Fig.1, we see that passing in matter thickness of more than 60 kg.cm^{-2} (equivalent to $\approx$400m through normal solar matter), electrons loose the polarisation completely. As a result, 50% of particles are oriented toward their moving direction, and 50% - backward. Concerning the flux intensity, we suggest that, in difference from normal solid matter, plasma does not capture electrons, but elastically scatter them only. In a significant thickness of homogenous plasma the scattering is always isotropic and the electron beam intensity must be conserved.

Further we are going to extend this formalism to the flux of solar neutrinos, considering them as time-like electrons or positrons, initially polarised 100% by alignment of their

pseudo-spin toward the time direction, i.e. toward the future. Passing through tachyon dark matter plasma, confined in the black hole, neutrinos are elastically scattered and their pseudo-spin after depolarisation is equally oriented toward and backward the time axis, and their beam intensity is not changed due to absence of capture. Among them, 50% remaining oriented towards the future direction, i.e. co-existing with us as space-like observers, and can be observed as solar neutrinos. While 50% are moving to the past, i.e. becoming anti-particles. For definition we recall that Dirac neutrino is space-like left-handed, while Dirac anti-neutrino is right-handed and they are different each from other. In case of solar neutrino, its anti-particle after pseudo-spin reversion remains the same space-like left-handed. Therefore, solar neutrino and its anti-particle are identical time-like bradyons having opposite pseudo-spin projection (to- and anti-time axis), which are completely similar to a normal electron able to exist in one of the two states with opposite spin projection +1/2 or -1/2 along the space-like moving direction. As a result, we found that anti-particle of neutrino is not Dirac one, but it looks like Majorana one. Moreover, time-reversed neutrino are not real anti-particle from the view-point of time-like observers. Meanwhile, it is left-handed, in difference from realistic observable Dirac anti-neutrino. Going backward to the past time, Majorana anti-neutrinos, consisting 50% of the total initial solar neutrino flux, are not able to be detected by terrestrial observatories, and they remain sterile neutrinos. In our terrestrial experiments one can observe only 50% neutrinos going toward the future in consistency with experimental data shown in Table 2. This is one of alternative explanation of the observed total rate of solar neutrinos.

Similar to a normal space-like unpolarised electron beam, the total solar neutrino flux reached the Earth consists of two components with opposite pseudo-spin projections. These two components equally interact with tachyon dark matter in the media they are passing through from the Sun to the Earth. A dynamic balance is established to keep the ratio 50:50 between the observable neutrino flux and the sterile component unchanged. This behaviour predicts the absence of both day-night and seasonal effects. Super-Kamiokande experimental data [9,13] seem to confirm this assumption.

IV. CONCLUSION

In this paper we show that neutrinos are realistic tachyons and according to the dual principle, are time-like leptons, simultaneously, which have pseudo-spin instead of conventional space-like spin. Due to weak interaction, the observable minus square mass and real part of transcendent mass of those tachyons should be dynamically suppressed by a factor ρ^2, which is negligible small to measure and neutrinos are detected almost as luminous particles. Suppression of tachyon mass leads to a possibility for a black hole to exist inside the Sun, which serves a location of dark matter plasma. As a result, after depolarisation of neutrinos by reversing their pseudo-spin while passing through the dark matter area, only half of them are remaining detectable. The other 50% become some kinds of sterile neutrinos, moving backward to the past. Those sterile neutrinos are recognised as Majorana anti-neutrinos. A dynamic balance between observable and sterile components in interaction with tachyon dark matter on the way from the Sun to the Earth might explain the absence of the day-night and seasonal effects. Thus, the solar neutrino problem might be solved in this way.

The author appreciates the financial support of the National Basic Research Program for Natural Science sponsored by the Ministry of Science, Technology and Environment of Vietnam for 1999.

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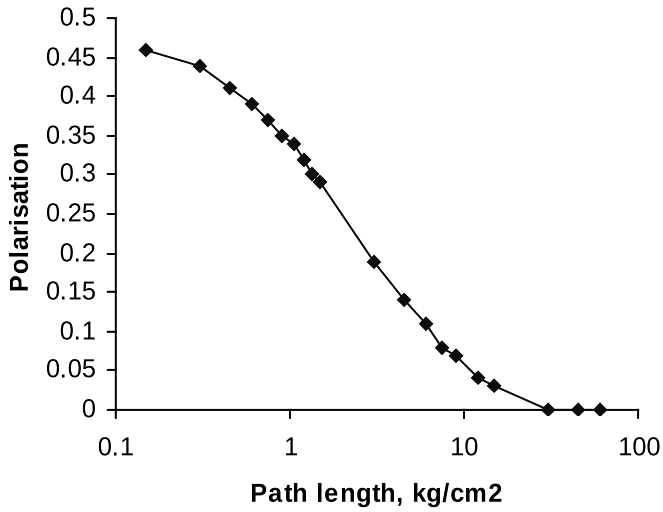
FIGURES

FIG. 1. Depolarisation of a polarised electron beam vs. thickness of scattering medium


0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Polarisation
0.1
1
10
100
Path length, kg/cm2